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The MSR System for Temporal Slot Filling at TAC 2013

Avirup Sil
Temple University, Philadelphia
avi@temple.edu

Silviu Cucerzan
Microsoft Research
silviu@microsoft.com

Outline

- Introduction to the Temporal Slot Filling Task
- Our Approach
  - Gathering Training Data from Wikipedia
  - Relationship Classifier
  - Date Classifier
- Experiments
- Conclusion and Future Work

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Previous work on Relation Extraction

" Bill Clinton, the forty-second president of the US, was the first to pay down principle.."

- Output of Relation Extraction systems [Etzioni et. al, 05, Agichstein & Gravano, 00]:
  - President_of(Bill Clinton, United States)
- Limitation:
  - Does not capture temporal validity of the relationship
    - President_of(Bill Clinton, USA) is true during time-frame 1993-2001

The Temporal Slot Filling Task

- Input:
  - A binary relation
    - Example: `spouse(Brad Pitt, Jennifer Aniston)`
  - A document supporting the relation

- Output:
  - A 4-tuple timestamp `[T1, T2, T3, T4]`
    - `[2000-07-29,nil, nil, 2005-10-02]`
  - A sentence supporting the temporal validity of the relation
    - *"Pitt married Jennifer Aniston on July 29, 2000… the couple divorced five years later in October 2, 2005."*

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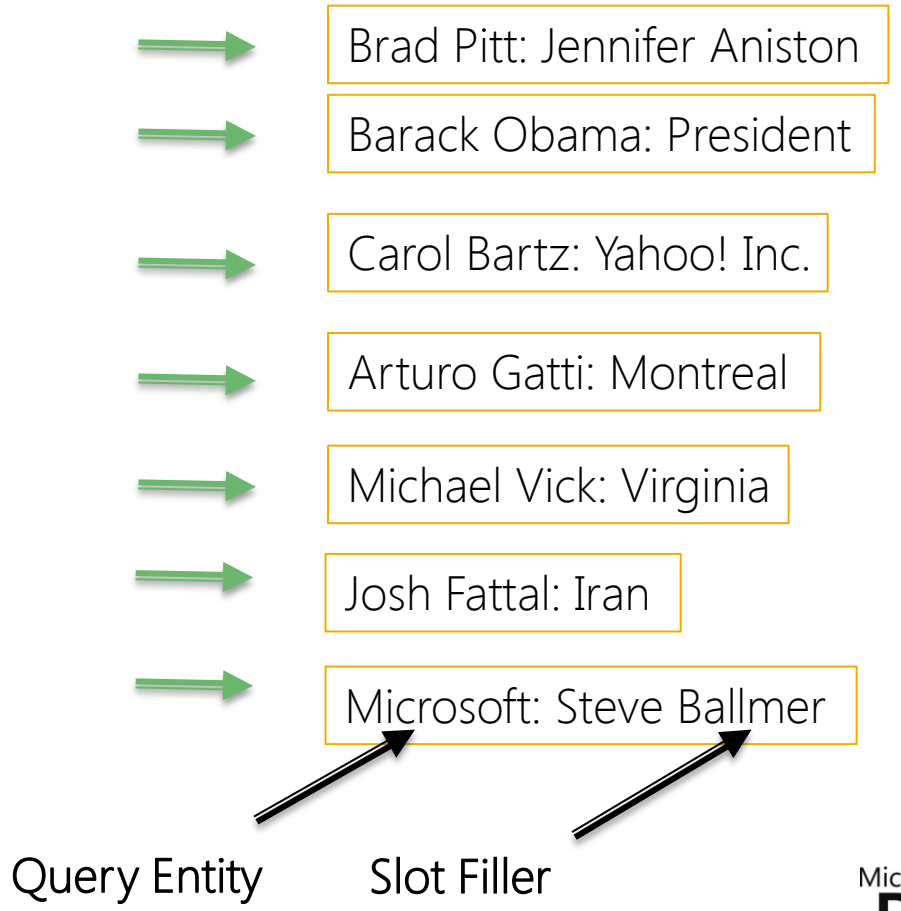
7 Relation Types

- Text Analysis Conference (TAC): Temporal Slot Filling track has the following relation types:
  1. Spouse
  2. Title
  3. Employee Of
  4. Cities of Residence
  5. States/Provinces of Residence
  6. Countries of Residence
  7. Top Employees/Members



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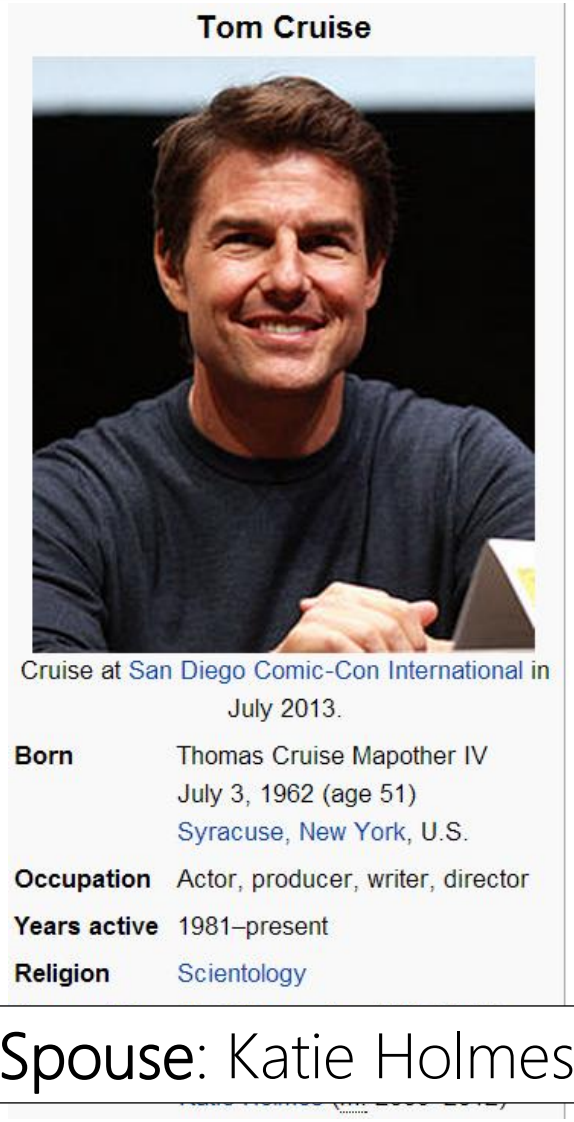
Gathering Training Data using Distant Supervision

- No training data available
- We build our own training data from Wikipedia sentences
  - For every relation:
    - Extract Slot-Filler Names from Infoboxes from all Wikipedia pages
    - Apply MSR Entity Linker to resolve entity disambiguation and coreferences
    - Collect sets of contiguous sentences containing the slot-filler names
    - Build a language model by bootstrapping [Agichtein & Gravano, 00] textual patterns supporting the relations



Spouse: Katie Holmes

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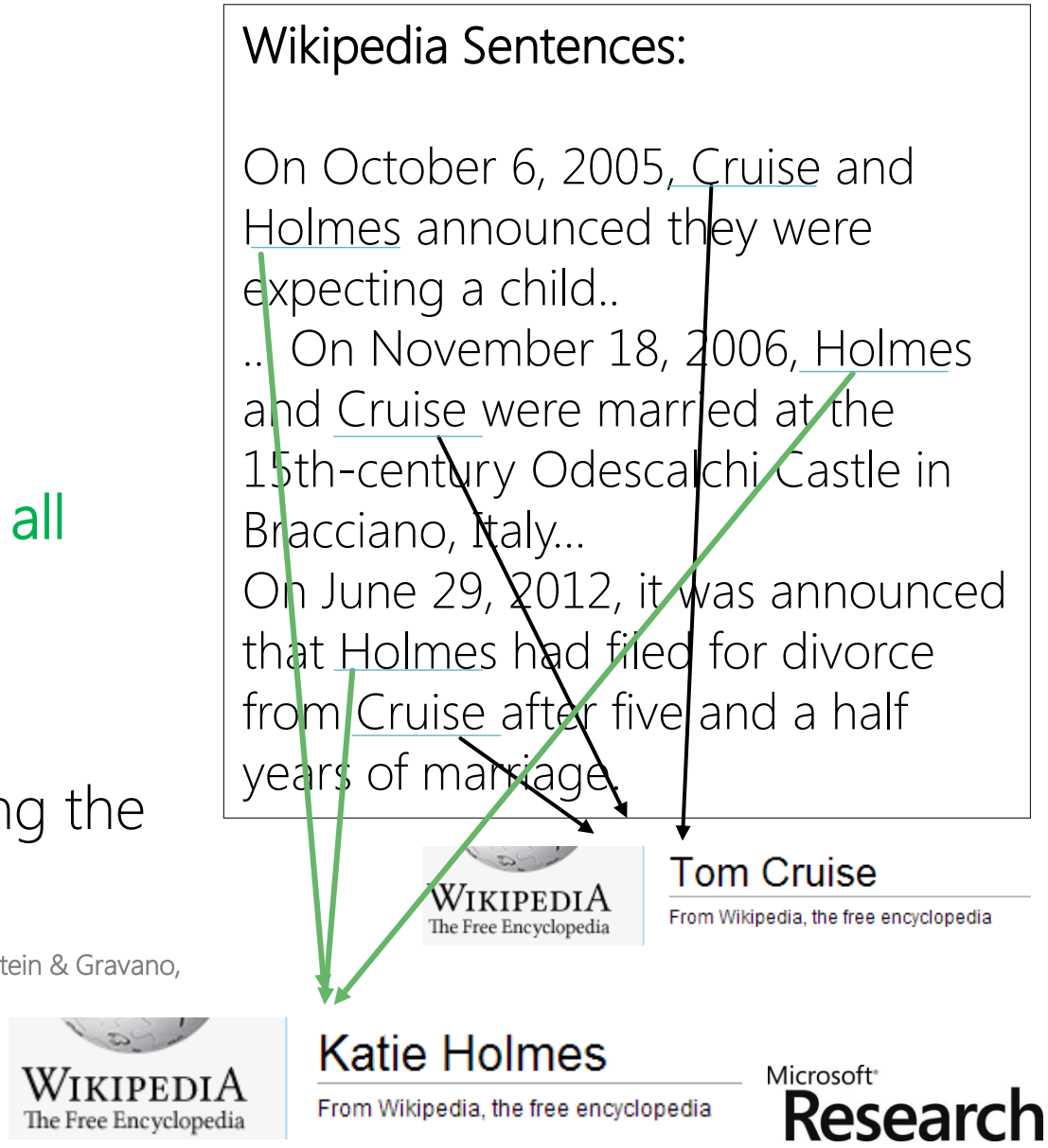

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Patterns Extracted:

- DATE: X and Y were expecting a child
- DATE: X and Y were married
- DATE: X had filed for divorce from Y
- …

X==Query Entity
Y== Slot Filler
We extract up to 5-grams.

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Normalizing Date Surface Forms

- We run Stanford SUTime [Chang & Manning, 12] to resolve date surface forms

Raw Input Document:

```
<DOC id="AFP_ENG_20090626.0737" type="story" >
<HEADLINE>Distraught Madonna 'can't stop crying' over Jackson</HEADLINE>
<DATELINE>Los Angeles, June 25, 2009 (AFP)</DATELINE>
<TEXT><P>Pop diva Madonna revealed she was left in tears over the death of
Michael Jackson on Thursday, saying the music world had lost ..</P>
</TEXT>
</DOC>
```

Document normalized with Timestamps:

```
<DOC id="AFP_ENG_20090626.0737" type="story" >
<HEADLINE>Distraught Madonna 'can't stop crying' over Jackson</HEADLINE>
<DATELINE>Los Angeles, June 25, 2009 (AFP)</DATELINE>
<TEXT><P>Pop diva Madonna revealed she was left in tears over the death of
<TIMEX3 t0="2009-06-25">Thursday</TIMEX3>  e music world had lost ..</P>
</TEXT>
</DOC>
```

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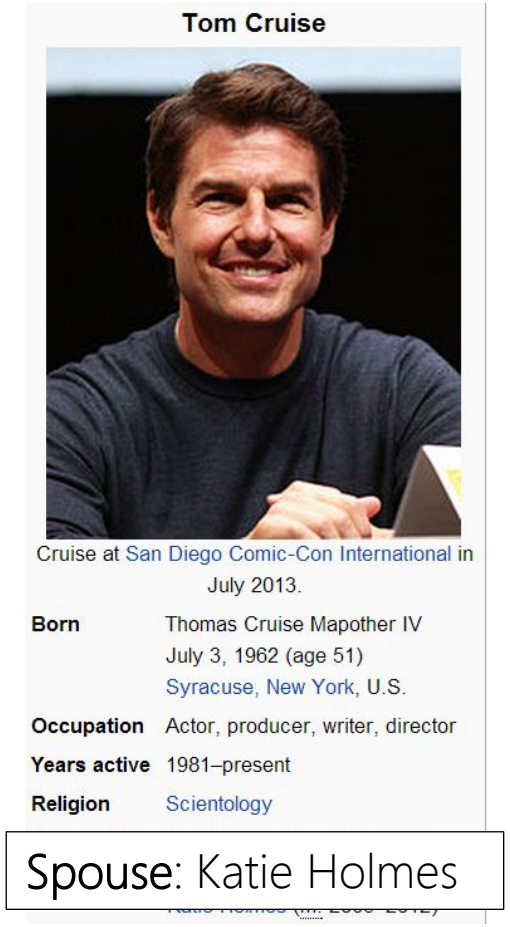
RelCl: Identifying positive vs. Negative Sentences

- Training:
  - Example:
    - Query Entity (X): Tom Cruise; Slot Filler (Y): Katie Holmes
    - Sentence 1: "*On November 18, 2006, Holmes and Cruise were married in Bracciano, Italy..*"
    - Sentence 2: "*In 2003, Cruise starred in the historical drama The Last Samurai..*"

Features	X and Y were married	Y, who died in DATE	were married in LOC	..	X married in DATE	X's wife Y	Y, who died	married	Label
Sentence 1	1	0	1	..	0	0	0	1	+1
Sentence 2	0	0	0	..	0	0	0	0	-1



- Classifier:
  - Boosted Decision Trees [Burges, 2010]

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RelCl: Identifying positive vs. Negative Sentences

- Testing:
  - Example:
    - Query Entity: Norris Church
    - Slot Filler: Norman Mailer

TAC TSF Eval Document

```
<DOC id="NYT_ENG_20101121.0120" type="story" >
<HEADLINE>NORRIS CHURCH MAILER, ARTIST AND
WRITER, DIES AT 61</HEADLINE>
<TEXT>
<P>Norman Mailer, whom Norris married in
1980, was an attentive father..</P>
<P>Norman Mailer, who died in 2007 at
84, who dreamed up Church because he..</P>
<P>Norris gave birth to John Buffalo in 1978
and spent..</P>
```

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Features	X and Y were married	Y, who died in DATE	were married in LOC	..	X married in DATE	X's wife Y	Y, who died	married
Sentence 1	0	0	0	..	1	0	0	1
Sentence 2	0	1	0	..	0	0	1	0
Sentence 3	0	0	0	..	0	0	0	0

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Sentence 3	0	0	0	..	0	0	0	0

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DateCL: Date Classification using Trigger Words

- Goal: Predict 4-tuple timestamp `[T1, T2, T3, T4]`
- DateCl: A classifier using language models for "**Start**", "**End**" and "**In**" predictors of relationship
  - Start predicts T1, T2; End predicts T3, T4; In predicts T2, T3
  - These compose of "Trigger Words". Example for spouse relation:
    - Start: {married since _DATE, married SLOT_FILLER on,..}
    - End: {estranged husband QUERY_ENTITY, split in _DATE, SLOT_FILLER died,..}
    - In: {happily married, QUERY_ENTITY with his wife,..}

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Extracting Timestamps

- Example:
  - How to identify START?
    - "Norman Mailer, whom Norris married in 1980, was an attentive father.."
    - "Y, whom X married in _DATE, was an attentive father.."
    - Indicates START of a "marriage" relationship
      - T1 = 1980-01-01; T2 = 1980-12-31; Justification_String: "1980"
  - How to identify END?
    - "Norman Mailer, who died in 2007 at 84,.."
    - "Y, who died in _DATE at 84,.."
      - Indicates END of a "marriage" relationship
        - T3= 2007-01-01; T2 = 2007-12-31; Justification_String: "2007"
  - Aggregate the timestamps (based on Classifier confidence and heuristics):
    - [1980-01-01 1980-12-31 2007-01-01 2007-12-31]

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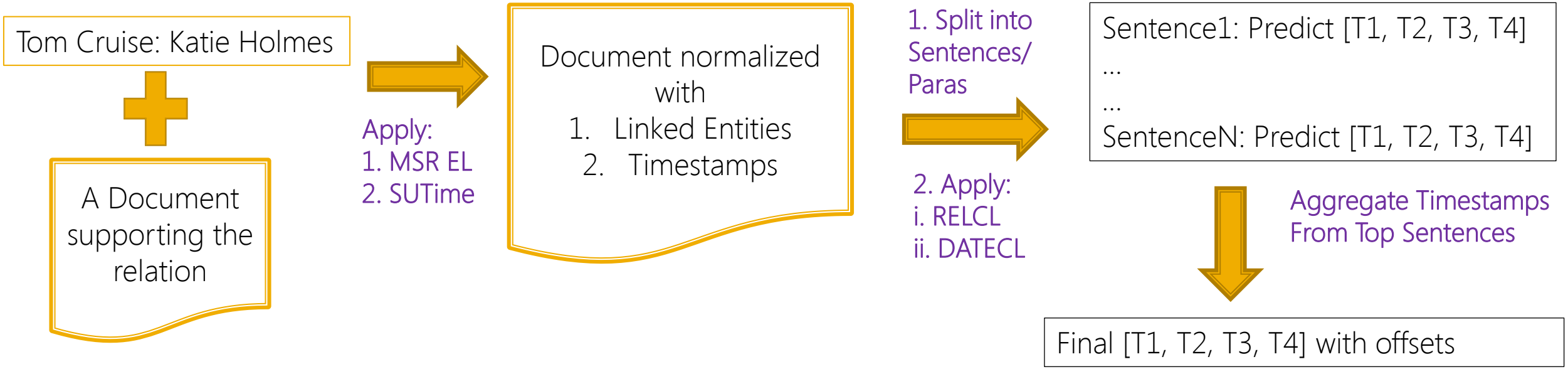
Predicting the timestamps (single-document prediction)



Update of the dates:

1. Initialize T= [-∞, +∞, -∞,+ ∞]
2. Iterate through classified timestamps
3. For a new T' aggregate :
   - T && T'= [max(t_1,t_1'), min(t_2,t_2'),max(t_3,t_3'), min(t_4,t_4')]
   - Update only if $t_1 \leq t_2$; $t_3 \leq t_4$; $t_1 \leq t_4$

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Experiments

- Dataset:
  - Wikipedia (May 2013)
    - Divide into Train and Dev
    - Train our RELCL and DATECL on Wikipedia training data
  - TAC
    - Training Data (7 examples; 1 per relation)
    - Evaluation Data (only for final test)
      - 273 examples (39 examples per relation)
- Evaluation Metric (as per TAC):
  - $S(relation) = \frac{1}{4}\sum_{i=1}^{4}\frac{1}{1+d_i}$, $d_i = |r_i - k_i|$

Results

- On TAC 2013 Dataset

	Relations							
Run ID	Title	Spouse	EmployeeOf	CitiesOfRes	StatesOfRes	CountriesOfRes	Top_Employee	Overall
MS_MLI1	0.251	0.238	0.301	0.249	0.319	0.228	0.281	0.267
MS_MLI2	0.273	0.330	0.401	0.361	0.319	0.328	0.319	**0.331**

- Comparison:

Team	Mean Temporal Score (201 queries)
LDC	0.688 (Human)
MSR_TSF (Our System)	**0.331**
Team2	0.234
Team3	0.148
Team4	0.115
Team5	0.051

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Conclusion and Future Work

- Wikipedia data proved to be an effective resource for the TSF task
  - Best performance in the task
- In the absence of annotated data **distant supervision** becomes effective
- Future (and ongoing) Work:
  - Using more than 1 single document for extracting Timestamps
  - Perform Joint-Relation extraction and Temporal Constraint attachment

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Thanks!

- per: internOf(Avirup Sil, MSR): [2013-06-10,--,--,2013-09-06]
- Email:
  - avi@temple.edu
  - silviu@microsoft.com

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